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(54) [Title of the Invention] CONNECTOR PROVIDED WITH FILTER

(57) [Abstract]

[Object] The object of the present invention is to remove a transmission noise and emission noise, prevent degradation of insulation with time, prevent damage to capacitor caused by thermal expansion, provide high performance, and decrease size at low cost.

[Structure] Connector pins 13 are passed via through holes 12, extended from a base plate 12 of a housing 11, and secured therein. A shield case 14 having a window 15 surrounding the through holes is covered on the housing. A printed substrate 20 has pin holes 20a which can be fit onto the pins. A ground conductor 21 insulated from the pins is formed on the rear surface, except the areas surrounding the holes. Inner conductors 22 connected to the pins are formed individually for each hole on the front surface around the pins. A separation conductor 23 connected to the ground conductors is formed on the front surface so as to be insulated from the inner conductors with spacers 22a. The

substrate is inserted into the window so as face the top plate, and the separation conductor is connected to the window. Chip capacitors 30 are arranged at a ratio of one capacitor per two neighboring inner conductors on the substrate surface. Their outer electrodes 31, 32 are connected to the inner conductors, and their ground electrodes 33, 34 are connected to the separation conductor.

[Patent Claims]

[Claim 1] A connector provided with a filter, comprising:

an insulating housing (11) provided with a plurality of through holes (12a) in a housing top plate (12),

a plurality of connector pins (13) which pass through said plurality of through holes (12a) and are secured therein, one end of each pin being located inside said housing (11) and another end protruding from said top plate (12),

an electrically conductive shield case (14) covered on said housing (11) and having a window (15) surrounding said plurality of through holes (12a),

a printed substrate (20) in which a plurality of pin holes (20a) are provided correspondingly to a plurality of through holes (12a) in said top plate (12) so that they can be fit onto said plurality of connector pins (13), a ground conductor (21) electrically insulated from said connector pins (13) is formed on the rear surface of the substrate, except zones around said pin holes (20a), a plurality of inner conductors (22) electrically connected to said connector pins (13) are formed individually for each pin hole (20a) on the front surface of the substrate around said pin holes (20a), a separation conductor (23) electrically connected to said ground conductor (21) is formed on the front surface of the substrate between said inner conductors (22) so as to be electrically insulated from said inner conductors (22) with spacers (22a), the rear surface of the substrate is inserted into the window (15) of said shield case (14) so as to be opposite said top plate (12) , and said separation conductor (23) or ground conductor (21) is electrically connected to said window (15),

and chip capacitors (30) arranged at a ratio of one capacitor per two neighboring inner conductors (22) of a plurality of inner conductors (22) formed on the front surface of said printed substrate (20), and having a pair of outer electrodes (31, 32) electrically connected to said two inner conductors (22) on two opposite side surfaces, and a pair of ground electrodes (33, 34) electrically connected to said separation conductor (23) on the two side surfaces other than said two side surfaces.

[Claim 2] A connector provided with a filter, as described in Claim 1, in which a plurality of through holes (12) are formed in two rows in the housing top plate (12), a plurality of connector pins (13) are passed through a plurality of through holes (12a) arranged in two rows and secured therein, a plurality of inner conductors (22) of the printed substrate (2) are formed in two rows on the front surface of the substrate individually for each pin hole (20a), the chip capacitor (30) is mounted between the two opposite inner conductors (22) of said inner conductors (22) arranged in two rows by electrically connecting a pair of outer electrodes (31, 32) per one respective inner conductor (22).

[Detailed Description of the Invention]

[0001]

[Field of Industrial Application] The present invention relates to a connector for connecting electronic devices. More specifically, the present invention relates to a connector provided with a noise filter, which is suitable for preventing penetration of noise from external sources and suppresses emission of noise generated inside the device.

[0002]

[Prior Art Technology] A problem associated with digital devices employing semiconductor elements, such as integrated circuits, is that they malfunction under the effect of transmission noise penetrating from external sources via power lines or signal lines, or emission noise penetrating by transmission in air, and that the internal circuit elements can be destroyed. Examples of conventional measures taken against the noise in order to resolve the above-described problem include a method of creating a LC low-pass filter circuit by combining a capacitor and an inductor on a printed circuit substrate for each signal line inside a device, and a method of mounting circuits in which low-pass filters were formed by combining these elements in advance.

[0003] However, the conventional capacitors and LC filters had a large residual inductance with respect to earth, and extended wiring in the circuit substrate increased the residual inductance, which often made it impossible to remove a high-frequency noise. In such a case, it was necessary to connect ground terminals to a plurality of signal lines, the wiring design of circuit substrates was very complex, and the number of connection points increased. As a result, the substrate surface area was increased and the mounting cost was raised. Furthermore, when a chip capacitor was installed on the substrate, the emission noise could not be removed.

[0004] Thus, a connector employed to connect electronic devices serves as a window for an emission noise, and the noise "jumps over" the noise filter mounted on the printed substrate, creating obstacles between the devices. Connectors provided with a filter, in which a through capacitor was incorporated in the connector connecting the electronic devices, have been employed to remove such an emission noise. A connector provided with a filter, which has a shield structure incorporating a through capacitor, were directly installed on the device housing that served as a ground body providing for stable grounding. Therefore, the residual inductance generated at the ground side of the filter could be decreased by comparison with structures in which the filter was mounted on a printed substrate. Another advantage was that the device was electromagnetically shielded and a very good noise-reducing effect was obtained.

[0005]

[Problems Addressed by the Invention] The above-described connectors provided with a filter incorporating a through capacitor had the above-described merits, but also had the following drawbacks. First, when the through capacitor was soldered to a connector pin

and a window edge of the shield case, the components were sealed in a state in which the soldering flux penetrated in a space between the housing top plate and the soldered portion of the sealed case. As a result, the flux remained in the structure, causing gradual degradation of insulation in the through capacitor. Second, owing to a difference between a thermal expansion coefficient of the shield case and that of the housing, variations in ambient temperature caused different changes in dimensions of those two components. As a result, stress was applied to the through capacitor, sometimes causing cracking of the through capacitor or the like. Third, the number of operations required to manufacture the through capacitor and assemble the through capacitor with connector was large, which resulted in a high cost.

[0006] It is an object of the present invention to provide a connector containing a noise filter, which can remove the transmission noise and emission noise. Another object of the present invention is to provide a connector containing a noise filter in which the electric insulation between a contact pin and shield case does not degrade with time, and no damage to the capacitor is caused by thermal expansion. Still another object of the present invention is to provide a connector containing a filter in which high performance can be obtained and size can be decreased at a low cost by using a three-terminal or four-terminal chip capacitor.

[0007]

[Means to Resolve the Problems] A structure of the present invention created to attain the above-described object will be described below with reference to Fig 1, Fig 2, and Fig 3 illustrating an embodiment thereof. The connector provided with a filter in accordance with the present invention comprises an insulating housing 11 provided with a plurality of through holes 12a in a housing top plate 12, a plurality of connector pins 13, an electrically conductive shield case 14, a printed substrate 20, and chip capacitors 30. A plurality of connector pins 13 pass through a plurality of through holes 12 and are secured therein, one end of each pin being located inside the housing 11 and another end protruding from the top plate 12. The electrically conductive shield case 14 is coated on the housing 11 and has a window 15 surrounding a plurality of through holes 12a. The printed substrate 20 is provided with a plurality of pin holes 20a correspondingly to a plurality of through holes 12a in the top plate 12 so that they can be fit onto a plurality of connector pins 13. A ground conductor 21 electrically insulated from the connector pins 13 is formed on the rear surface of the substrate, except zones around the pin holes 20a, and a plurality of inner conductors 22 electrically connected to the connector pins 13 are formed individually for each pin hole 20a on the front surface of the substrate around the pin holes 20a. A separation conductor 23 electrically connected to the ground conductor 21 is formed on the front surface of the substrate between the inner conductors 22 so as to be electrically insulated from the inner conductors 22. The rear surface of the substrate in the printed substrate is inserted into the window 15 of the shield case 14 so as to be opposite the top plate 12, and the separation conductor 23 is electrically connected to said window 15. Furthermore, chip capacitors 30 are arranged at a ratio of one capacitor per two neighboring inner conductors 22 of a plurality of inner conductors 22 formed on the front surface of the printed substrate 20, and have a pair of outer electrodes 31, 32

electrically connected to the two inner conductors 22 on two opposite side surfaces, and a pair of ground electrodes 33, 34 electrically connected to the separation conductor 23 on the two side surfaces other than the above-mentioned two side surfaces.

[0008]

[Operation] When the connector 10 is installed at a shielded device, the connector pins 13 are electrically connected to the shield case 14, which is a common ground, via the inner conductors 22 of printed substrate 20, chip capacitors 30, and separation conductor 23 of printed substrate 20. As a result, the residual inductance generated at the ground side of the connector 10 can be decreased and the transmission noise can be effectively removed. In particular, since a three-terminal or four-terminal chip capacitor is used and one capacitor 30 is arranged between two connector pins 13, it is not necessary to install one capacitor 30 per each connector pin 13 and the mounting space can be decreased. Furthermore, the emission noise generated inside the device and the emission noise penetrating from external sources can be completely shielded by the ground conductor 21 of printed substrate 20, the separation conductor 23 electrically connected thereto, and the shield case 14.

[0009]

[Embodiment] An embodiment of the present invention will be described below in greater detail with reference to the drawings attached. As shown in Fig 1 and Fig 2, an insulating housing 11 (made of a synthetic resin) of a connector 10 provided with a noise filter has an top plate 12. A total of 8 through holes 12a are formed in 2 rows each containing 4 holes in the top plate 12. Eight connector pins 13 are passed through the holes 12a and secured therein. One end of each connector pin 13 is located inside the housing 11 and its other end protrudes from the top plate 12. A shield case 14 covered on the housing 11 is formed by bending an electrically conductive sheet so as to obtain a box-like shape. The shield case 14 consists of a metal surface treated so as make it solderable, for example, of Fe, a Cu-Zn alloy (bronze) or the like. A window 15 surrounding the eight through holes 12a is provided in the upper surface of shield case 14. The edge of window 15 is bent inward to form a socket 15a. The shield case 14 is secured to the housing 11 in a state in which the connector pins 13 protrude from the window 15.

[0010] As shown in Fig 3 and Fig 4, a printed substrate 20 is provided with eight pin holes 20a which can be fit onto the eight connector pins 13 and five through holes 20b in the substrate center. A ground conductor 21 which is electrically insulated from the connector pins 13 is formed over the whole rear surface of the substrate, except the areas around the pin holes 20a. Furthermore, eight inner conductors 22 electrically insulated from the connector pins 13 are formed separately for each pin hole on the front surface of the substrate around the pin holes 20a. An H-like separation conductor 23 is formed on the substrate surface between the inner conductors so as to be electrically insulated from the inner conductors 22 by spacers 22a. The separation conductor 23 is electrically connected to the ground conductor 21 via through holes 20b.

[0011] A total of four chip capacitors 30 are arranged at a ratio of one chip capacitor per two neighboring inner conductors of a total of eight inner conductors formed on the front surface of printed substrate 20. The chip capacitors 30 have a four-terminal structure comprising a pair of outer electrodes 31, 32 electrically connected to the respective tow inner conductors 22 on two opposite side surfaces, and a pair of ground electrodes 33, 34 electrically connected to respective separation conductors 23 on the side surfaces other than the above-mentioned side surfaces.

[0012] As shown in Fig 5 – 7, the chip capacitor 30 comprises a laminate 65 prepared by alternately laminating a first rectangular ceramic dielectric sheet 40 and a second ceramic dielectric sheet 50 having the same size and shape as sheet 40, then placing a third ceramic dielectric sheet 60 having the same size and shape as sheet 40, but having no conductor formed on its surface, as an uppermost layer, and integrating the sheets. In the first ceramic dielectric sheet 40, a ground electrode 43 is provided on the sheet surface, this electrode being electrically connected to the central zones of two opposite sides of the sheet and having spacers 41, 42 which electrically insulate it from two other opposite sides of the sheet. Furthermore, the second ceramic dielectric sheet 50 is provided with a pair of inner electrodes 51, 52 which are electrically connected to two sides corresponding to the sides of sheet 40 which are electrically insulated from the ground electrode 43, and a separation electrode 53 which is electrically connected to the central zones of other two opposite sides and is located between the two inner electrodes 51, 52, being separated from the inner electrodes 51, 52 with spacers 54, 55.

[0013] As shown in Fig 7 and Fig 8, after the laminate 65 was fired, a pair of the above-described outer electrodes 31, 32 are electrically connected to the inner electrodes 51, 52 exposed on the two opposite side surfaces of the sintered body, and the above-described pair of ground electrodes 33, 34 are connected to the separation electrode 53 and ground electrode 43 and exposed on the other two opposite side surfaces of the sintered body of laminate 65. Furthermore, Figs 5, 7, and 8 show the sheet portion enlarged in the thickness direction to facilitate the explanation. The four chip capacitors 30 having the above-described structure are supported between the inner conductors 22 on the surface of printed substrate 20. Thus, the outer electrodes 31, 32 are connected by soldering to the inner conductors 22, and the ground electrodes 33, 34 are connected by soldering to the separation conductor 23.

[0014] The printed substrate 20 having four chip capacitors 30 mounted thereon in the above-described manner is fit into socket 15a of window 15 by fitting pin holes 20a, as shown in Fig 1, onto connector pins 13 and then inserting the substrate into the window 15 of the shield case 14 so that the rear surface of the substrate faces the top plate 12. Then, connector pins 13 are electrically connected to inner conductors 22 by soldering, and both ends of the separation conductor 23 on the substrate surface are electrically connected to the edge of window 15 by soldering. The protruding ends of connector pins 13 are bent, if necessary, at an almost right angle to insert them into a printed substrate (not shown in the figures) of an electronic device.

[0015] With the connector 10 provided with a noise filter having the above-described structure, when the shield case 14 is attached to an electronic device (not shown in the figures), the connector pins 13 are connected to outer electrodes 31 or 32 of chip capacitor 30 via inner conductors 22, and the ground electrodes 33, 34 of chip capacitor 30 are connected to the device housing via the separation conductor 23 and shield case 14. As a result, the residual inductance generated on the ground side after installation on an electronic device can be decreased and a transmission noise can be effectively removed. Furthermore, the window 15 in the shield case 14 of connector 10 is covered with the printed substrate 20, and the ground conductor 21 in the substrate 20 is provided over the whole rear surface by connecting to the shield case 14 via the separation conductor 23 located on the front surface. As a result, an emission noise generated inside the device or emission noise penetrating from outside of the device are shielded completely.

[0016] In the above-described embodiment, a plurality of connector pins were arranged in two rows. However, the present invention is also applicable to a structure in which the connector pins are arranged in one row. In such a case, one chip capacitor is installed per two neighboring inner conductors. Furthermore, in this embodiment, the chip capacitor consisted of a laminate consisting of a total of four sheets: two first ceramic dielectric sheets 40, one second ceramic dielectric sheet 50, and one third ceramic dielectric sheet 60. The present invention is, however, not limited to this number of sheets, and the number of sheets can be increased appropriately. Such an approach makes it possible to change the capacitance formed by the inner electrode and ground electrode.

[0017] Furthermore, the dielectric sheets constituting the chip capacitor may also have a structure shown in Fig 9 which contains no separation electrode 53 shown in Fig 6. In sheet 60 shown in Fig 9, a first inner electrode 61 is formed by printing; this electrode is electrically connected to one side and has spacers 62, 63, and 64 which electrically insulate it from the remaining three sides of the sheet. In sheet 70, a ground electrode 73 is formed by printing; this electrode has a portion which overlaps the first inner electrode 61 formed on the sheet 60 upon lamination, has spacers 71, 72 electrically insulating it from two sides, and is electrically connected to other two sides. Furthermore, in sheet 80, a second inner electrode 81 is formed by printing; this electrode is electrically connected to one side which is opposite to one side of sheet 60 to which the first inner electrode 61 is electrically connected, has spacers 82, 83, 84 which electrically insulate it from three remaining sides, and also has a portion which overlaps the ground electrode 73 of sheet 70. Those sheets 60-80 formed by printing are laminated with the uppermost sheet 90, and the laminate is fired in the same manner as in the above-described embodiment. Outer electrodes 31, 32 shown in Fig 8 are electrically connected respectively to inner electrodes 61, 81 which are exposed on both side surfaces of the sintered body. Ground electrodes 33, 34 are electrically connected to ground electrodes 73 exposed on other two opposite side surfaces of the sintered body.

[0018] Furthermore, a three-terminal chip capacitor in which any one of two ground electrodes 33, 34 was eliminated is also suitable for the purpose present invention.

[0019]

[Effect of the Invention] As described above, by contrast with the conventional connector containing a filter incorporating a through capacitor, in the connector with a filter in accordance with the present invention, the thermal expansion coefficient of the printed substrate is made close to that of the housing. As a result, thermal stresses provided to the chip capacitor are decreased and damage of the capacitor caused by thermal expansion is prevented. Since soldering flux does not penetrate inside, the electric insulation between the connector pins and shield case is not degraded with time. Furthermore, because the connector pins are connected to outer electrodes of the chip capacitor via the inner conductors and the ground electrode of the capacitor is connected to the shield case via the separation electrode and shield case (sic), the transmission noise can be reliably removed. Moreover, since the window of the shield case is covered with the grounded separation conductor and ground conductor, the emission noise penetrating by transmission in air can be completely shielded. In addition, the connector provided with a filter in accordance with the present invention is manufactured by employing three-terminal or four-terminal chip capacitors that are mass products, mounting one chip capacitor on a printed substrate for two connector pins, and fitting the printed substrate onto the connector pins and inserting it into the shield case. As a result, the mounting density of the capacitor is very high, its size can be decreased, very few assembly operations are required, and an inexpensive connector provided with a filter can be obtained.

[Brief Description of the Drawings]

Fig 1 is a cross sectional view along line A – A in Fig 2 illustrating the connector provided with a filter, which is an embodiment of the present invention.

Fig 2 is a perspective view of the connector before the connector pins are bent.

Fig 3 is a plan view of a printed substrate with a chip capacitor mounted thereon.

Fig 4 is a rear view of the printed substrate.

Fig 5 is a cross sectional view along line B – B in Fig 8 illustrating the chip capacitor.

Fig 6 is a perspective view of the laminate prior to lamination.

Fig 7 is a perspective view of a sintered body obtained by firing the laminate.

Fig 8 is a perspective view of the chip capacitor.

Fig 9 is a perspective view of a laminate constituting a chip capacitor of another embodiment prior to lamination.

[Legends]

10 – connector provided with a filter
11 – insulating housing
12 – housing top plate
12a – through hole
13 – connector pin
14 – shield case

15 – window
20 – printed substrate
20a – pinhole
21 – ground conductor
22 – inner conductor
22a – electrically insulating spacer
23 – separation conductor
30 – chip capacitor
31, 32 – outer electrode
33, 34 – ground electrode

Fig 1

10 – connector provided with a filter
11 – insulating housing
12 – housing top plate
12a – through hole
13 – connector pin
14 – shield case
15 – window
20 – printed substrate
20a – pinhole
30 – chip capacitor
31, 32 – outer electrode
33, 34 – ground electrode

Fig 2

Fig 3

20 – printed substrate
20a – pinhole
21 – ground conductor
22 – inner conductor
22a – electrically insulating spacer
23 – separation conductor
30 – chip capacitor
31, 32 – outer electrode
33, 34 – ground electrode

Fig 4

20 – printed substrate
20a – pinhole
21 – ground conductor

Fig 5

30 – chip capacitor
31, 32 – outer electrode
33, 34 – ground electrode
40 – first ceramic dielectric sheet
41, 42 – electrically insulating spacers
43 – ground electrode
50 – second ceramic dielectric sheet
51, 52 – inner electrodes
53 – separation electrode
54, 55 – electrically insulating spacers
60 – third ceramic dielectric sheet

Fig 6

Fig 7

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